

# Investing In America's Energy Future

*Energy Strategic Goal: To protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy.*

*"Energy, of course, is a vital component of our work. We must promote and execute both practical and visionary policies that will secure the energy we need to guarantee our continued economic growth and prosperity today and in the years and decades ahead."*

Spencer Abraham  
Secretary of Energy

The demand for energy in the U.S. is rising much faster than the projected increase in domestic energy production. The shortfall between energy demand and domestic supply is projected to increase nearly 50 percent by 2020. That projected shortfall can be made up in only three ways – import more energy, improve energy conservation and efficiency, and/or increase domestic supply.

The Administration considered these options in its development of the National Energy Policy (NEP). It concluded that increased dependence on oil imports from volatile regions of the world would jeopardize our national and economic security. As our dependence on oil rises, so does our vulnerability to price shocks, shortages, and disruptions. For that reason, the Administration resolved to take steps to improve energy conservation and efficiency and increase domestic energy production in order to avoid increased dependence on imports. That was the hallmark of the NEP issued in May 2001 and remains the heart of our Nation's energy strategy.

Science and technology are the Department's principal tools for achieving the goals of the NEP. The Department invests in high-risk, high-value energy research and development that the private sector alone would not or could not develop in a market-driven economy. We are developing technologies to allow renewable energy to play a more important role in the future of our Nation.

The following Offices within the Department are working toward the energy security goal:

The Office of Fossil Energy (FE) addresses issues related to the security, affordability, and environmental acceptability of fossil fuel supply and use. For the Clean Coal Program, this is carried out through public/private partnerships to develop technology that will ensure continued electricity production and potential future large scale hydrogen production from the extensive U.S. coal resource. For oil and gas, FE implements a policy, and technology development program to diversify natural gas supply

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options and improve oil exploration and production capabilities.

FE also operates two facilities which comprise the Nation's first line of defense against severe petroleum product shortages, including: 1) the Strategic Petroleum Reserve (SPR), which provides emergency oil supplies in the event of a serious supply disruption; and 2) the Northeast Heating Oil Reserve, which helps ensure adequate heating oil supplies in the event of severe energy disruptions.

The Office of Nuclear Energy, Science and Technology (NE) leads the government's efforts to develop new nuclear energy generation technologies to meet energy and climate goals to develop advanced, proliferation-resistant nuclear fuel technologies that maximize energy from nuclear fuel, and to maintain and enhance the national nuclear technology infrastructure. NE serves the present and future energy needs of the country by managing the safe operation and maintenance of our critical nuclear infrastructure that provides nuclear technology goods and services. Nuclear power produces no greenhouse gas emissions and can play a significant role in reducing our dependency on foreign oil.

NE's research and development (R&D) programs are focused on (1) assisting the nuclear power industry in lowering the licensing risks associated with building nuclear power plants; (2) developing technologies for the next-generation of nuclear power plant plants; (3) developing technologies for the efficient generation of large commercial quantities of hydrogen using nuclear power; and (4) developing technologies that significantly reduce the long-term storage requirements of spent nuclear fuel.

NE also maintains a robust isotope production program, providing radioisotope-based power systems for deep space exploration and national security missions and providing a variety of users with the specific research and medical isotopes to meet their needs. In addition, NE's University Reactor Infrastructure and Education Assistance program enables the Nation to maintain a stable number of talented nuclear engineering and science graduates needed for industry, academia and national laboratories.

The Office of Energy Efficiency and Renewable Energy's (EERE) mission is to strengthen America's energy security, environmental quality, and economic vitality through public-private partnerships that

promote energy efficiency and productivity, bring clean, reliable and affordable energy technologies to the marketplace, and make a difference in the everyday lives of Americans by enhancing their energy choices and quality of life. Examples of how some of these key department drivers are addressed by the eleven EERE programs include:

- Replacement of Conventional Fuels – the Vehicle Technology and Hydrogen programs work together through the FreedomCAR Partnership and Hydrogen Fuel Initiative to develop technologies that have the potential to virtually eliminate the use of petroleum for transportation over the next several decades. One of the major technical challenges we are addressing is the means to store sufficient amounts of hydrogen aboard the vehicle to provide a driving range of greater than 300 miles.
- Clean, affordable renewable energy sources – EERE's Wind Technology research and development program successfully graduated its high speed wind effort, meeting its cost of energy goal of 3 cents/kilowatt hour in strong winds. The program is now developing next-generation technologies to operate cost effective wind power in moderate speed winds, which will significantly expand the opportunities to use wind power nationwide.
- Clean, reliable energy – based upon DOE sponsored R&D, conducted by the Distributed Energy Resources program within EERE, the Mercury 50 Turbine was offered as a commercial product. This R&D enables "mission-critical" operations when grid-connected power is not available and improves the use of distribution assets by reducing the peak or altering the shape of energy demand.

The mission of the Office of Electric Transmission and Distribution (OETD) is to lead a national effort to modernize and expand America's electric delivery system to ensure a more reliable and robust electricity supply, as well as economic and national security. This effort is accomplished through research, development, demonstration, technology transfer, and education and outreach activities in partnership with industries, businesses, utilities, states, and other federal programs and agencies, universities, national laboratories, and other stakeholders.

## Energy General Goal

### Performance Scorecard:

ENERGY SECURITY (\$ in Millions)

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GENERAL GOAL	FY04 PROGRAM COST	FY03 PROGRAM COST	PROGRAM GOALS	*FY 2004 Budgetary Expenditures Incurred	OVERALL PROGRAM SCORE	PERFORMANCE OF ANNUAL TARGETS			
						MET	NOT MET (≥80%)	NOT MET (<80%)	UNDETERMINED
Energy Security	\$6,378	\$6,235	Zero Emissions Coal-Based Electricity and Hydrogen Production	\$346		10	0	2	
			Natural Gas Technologies	\$54		5	0	0	
			Oil Technology	\$62		3	0	0	
			Petroleum Reserves	\$269		2	0	0	
			Develop New Nuclear Generation Technologies	\$107		2	0	1	
			Nuclear Fuel Technologies	\$84		3	0	0	
			Maintain and Enhance National Nuclear Infrastructure	\$235		5	0	0	
			Hydrogen/Fuel Cell Technologies	\$81		11	0	1	
			Vehicle Technologies	\$209		4	1	0	
			Solar Energy	\$171		3	0	0	
			Building Technologies	\$64		3	0	1	
			Wind Energy	\$49		2	0	0	
			Hydropower	\$6		2	0	0	
			Geothermal Technology	\$23		0	0	2	
			Biomass and Biorefinery Systems R&D	\$76		4	0	1	
			Weatherization	\$256		2	0	0	
			State Energy Programs	\$102		2	0	0	
			Intergovernmental Activities	\$16		4	1	3	
			DEMP/FEMP	\$22		3	0	2	
			Distributed Energy Resources	\$61		4	0	1	
			Industrial Technologies	\$132		3	0	0	
			Electric Transmission and Distribution	\$72		2	0	1	
			Southeastern Power Administration	\$36		4	0	0	
			Southwestern Power Administration	\$34		5	0	0	
			Western Area Power Administration	\$752		4	0	0	
			Bonneville Power Administration	\$4,355		3	0	0	
			Energy Information Administration	\$85		3	0	0	
Total Cost	\$6,378	\$6,235		\$7,759		98	2	15	0

\*Includes capital expenditures but excludes such items as depreciation, changes in unfunded liability estimates and certain other non-fund costs, and allocations of Departmental administration activities.

The value of the Department is not just found in R&D projects. The Power Marketing Administrations market and deliver reliable, cost-based Federal hydroelectric power and related services to customers over much of the southeastern, central and western United States. Transmission systems owned by the Power Marketing Administrations are part of the nation's interconnected generation and transmission system and make a significant contribution to the country's current energy supply. While the Power Marketing Administrations assure that customers receive the benefits of Federal power, they collect sufficient revenue to repay the American taxpayer's investments allocated to power within the timeframes established by law and regulations.

The following sections contain an overview of the results associated with performance against the most significant energy goals and annual targets for FY 2004.

#### Energy Security – General Goal 4:

**Improve energy security by developing technologies that foster a diverse supply of reliable, affordable, and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.**

Secretary Abraham declared that the Department has “an ambitious, long-term vision of a zero emission future, free of reliance on imported energy.” The programs supporting this General Goal follow through with the President's promise for a strong, secure economy, and an energy-independent future. Investments that are being made will expand our Nation's energy supply, assess and address our Nation's energy infrastructure vulnerabilities, and develop energy assurance activities consistent with the NEP.

The Department's technologies draw on all our available resources: oil; natural gas; coal; nuclear energy; renewable energy sources including hydropower, wind, solar, bioenergy, and geothermal; and reductions in demand through conservation and energy efficiency technologies and processes. The Administration believes it is not the role of the Federal Government to choose the energy sources for the country. Instead, the role of the Federal Government is to do high-risk, long-term R&D in areas where the private sector will not invest, and to allow the market to decide how much of each energy source is actually used. Diversity of energy sources (e.g., fossil, nuclear, and renewables) can help provide stability and guard against price spikes.

The Administration's energy portfolio takes a long-term focus through investments in hydrogen use and production, electricity reliability, and advanced

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coal and nuclear energy power technologies. Investments in these pivotal areas honor a commitment to strengthen the Nation's energy security, not just in the near-term, but for generations to come.

The Nation's long-term energy solution will come not from the development of a single energy source but from a broad portfolio of energy supply options. Fossil energy is an essential component of a comprehensive energy strategy. The Department has invested in the President's Coal Research Initiative. Under this initiative, the Department is working to dramatically improve the efficiency and environmental protection being developed for coal burning power production by conducting research and development on coal-related technologies to improve coal's competitiveness in future energy supply markets. To address our Nation's ongoing need for oil and gas, the Department continues to develop and promote technologies that can both lower costs of oil and natural gas exploration and development, and maximize America's energy supply. To minimize the impact of oil supply disruptions, the Department is committed to filling the Strategic Petroleum Reserve to 700 million barrels.

The Department is at the forefront of implementing the President's Hydrogen Fuel Initiative to reduce America's growing dependence on oil. Hydrogen holds the promise of an ultra-clean and secure energy option for America's future because it can be produced from domestic sources. In addition, DOE continues to emphasize R&D to improve energy efficiency and reliability in homes, buildings, transportation, and industry, and to reduce the cost of renewable and related energy technologies such as wind, solar, geothermal, and biomass.

Nuclear energy remains a critical component of the Nation's energy portfolio and a significant part of America's energy future. The Department's nuclear energy programs are working together to develop advanced nuclear power technologies. This includes the Department's Nuclear Hydrogen Initiative which is focused on the development and demonstration of nuclear technologies necessary for the commercial production of hydrogen using nuclear power. Furthermore, the Department is working to develop advanced systems that are more proliferation resistant, and have reduced life cycle costs. The Department is also continuing to develop proliferation-resistant fuel treatment technology that

reduces the volume and toxicity of high-level waste to optimize storage capacity of the first U.S. repository and reduce the need for additional repositories.

The Department is also developing technologies to assure the reliability of energy delivery. The Department is advancing technologies that will upgrade America's aging electricity infrastructure, relieve congestion on transmission and distribution systems, and develop superconducting materials that will improve the reliability of transmission system components.

The Department's Power Marketing Administrations sell and deliver electricity primarily generated from hydropower projects located at federally-owned dams. This clean, low-cost, renewable energy benefits customers throughout the southeastern, central and western states.

### *External Factors*

The following external factors could affect our ability to achieve this goal:

- **Technology:** Technological development is inherently unpredictable. Our efforts to develop zero-emission fossil generation technology, hydrogen, renewable energy, advanced nuclear power and fusion may be more or less successful than predicted, with a correspondingly positive or negative impact on our efforts.
- **Market Forces:** Whether new technology is deployed depends to a large extent on whether that technology is competitive, considering relevant policies (e.g., tax incentives for the purchase of fuel-cell vehicles) and future energy prices.
- **Consumer Choice:** Improved energy efficiency is largely the result of millions of decisions by individual consumers. The Department can help develop improved technology, but whether this technology is deployed depends on consumer decisions, including the market price of energy and relevant policies that may affect those decisions. In addition, the deployment of hydrogen and alternative fueled vehicles depends to a large extent on the decisions by individual consumers to purchase these vehicles.
- **Nonproliferation Policy:** Deployment of advanced fuel cycle technologies will depend upon policy changes permitting fuel reprocessing.



## How We Serve the Public

The offices that contribute to this General Goal are involved in a broad range of projects and activities that seek to merge cutting edge technologies with responsible energy practices. Examples of how each has served the public throughout FY 2004 are discussed below.

FE conducts research and development to enhance our recoverable oil and natural gas resources. Direct benefits to the public include improving exploration and drilling technologies, which may increase the total recoverable domestic resources of oil and gas. This could decrease our reliance on foreign sources of energy. Additional benefits also include decreasing harmful emissions of and improving the efficiencies of technologies related to energy production and use; and ensuring the availability of clean and affordable energy. The Strategic Petroleum Reserve and Northeast Home Heating Oil Reserve protect Americans from the severe adverse economic effects of petroleum supply disruptions.

In addition to exploring more efficient uses of our fossil energy resources, the Department is making advances in nuclear energy.

NE provides the following:

- Next-generation reactor technologies for producing electricity and hydrogen using nuclear power more efficiently and safely;
- Advanced fuel cycle technologies for reducing the volume and radiotoxicity, and increasing the proliferation-resistance of spent nuclear fuel, making nuclear energy more economical and environmentally friendly;
- Plutonium-based heat and power systems for National Aeronautics and Space Administration's (NASA) deep space exploration missions;
- Research and medical isotopes needed by a variety of paying customers; and,
- Nuclear reactor fuel and reactor upgrades to universities across the nation, as well as the financial assistance to nuclear engineering and science undergraduates and graduate students.

Cooperative arrangements at all levels of government illustrate the Department's commitment to responsible energy use.

On November 20, 2003, the Secretary of Energy joined by Ministers representing 15 nations and the European Commission, signed an agreement formally establishing the International Partnership for the Hydrogen Economy (IPHE). The IPHE is an international mechanism to coordinate hydrogen research and hydrogen technology development and deployment.

On February 19, 2004, the Secretary announced a new effort to educate state and local government officials on the vision of a hydrogen economy. "Hydrogen Power: The Promise, The Challenge" is a six-city national tour that commenced in Lansing, Michigan on March 23, 2004. Working with regional, state, and local partners, the Department offers "Hydrogen 101" to State and local officials who do not have a technical background, but are interested in learning more about hydrogen and fuel cell technologies, hydrogen safety, and the challenges to achieving the hydrogen vision.

On March 2, 2004, DOE and the U.S. Environmental Protection Agency (EPA) honored winners of the 2004 EnergyStar® Partner of the Year awards. EnergyStar® is a national symbol for energy efficiency that promotes energy savings by labeling products that exceed federal specifications for energy use. The awards highlight the efforts of leading manufacturers, retailers, utility companies, and a variety of state and regional programs that promote energy efficiency and awareness of the EnergyStar® label, which helps consumers identify the most energy-efficient products in the marketplace. Appliances, lighting, office equipment, home electronics, windows, and more can qualify by meeting the program guidelines. According to the EPA, consumer savings to date for all EnergyStar® activities is \$9 billion.

On March 9, 2004, the Secretary launched a national public service advertising campaign designed to make children and their parents aware of energy efficient behavior through a new "spokes-villain," the Energy Hog, an energy waster. The Energy Hog and the campaign were developed by the Advertising Council and Energy Outreach Colorado and are sponsored by DOE, The Home Depot, the North American Insulation Manufacturers Association, the National Fuel Funds Network, and the Colorado Governor's Office of Energy Management and Conservation, who were

all present for the launch. Nineteen state energy offices, in addition to Colorado's, are also sponsors.

OETD's R&D directly benefits the public by leading the modernization and expansion of the Nation's electricity delivery system (the grid). These improvements will reduce the risk of multi-regional blackouts (such as the August 2003 blackout) by providing faster detection of problems, and more wide-spread operator awareness of local outages, load imbalances, frequency and voltage problems, and other faults.

Finally, the Power Marketing Administrations serve the public through delivery of reliable low-cost power and related services to many hundreds of customers including municipalities, cooperatives, public utility and irrigation districts, Federal and State agencies, and Native American tribes. The marketing efforts and delivery capabilities of the Power Marketing Administrations provide for recovery of annual operating costs as well as repayment of taxpayer investment in the Federal hydropower system.

## **Program Goals and Targets Supporting Energy Security**

### **Fossil Energy**

The United States relies on fossil fuels for about 85 percent of the energy it consumes and forecasts indicate that the percentage value will increase in the future. The Department's FE activities are designed to ensure that the economic benefits from moderately priced fossil fuels are compatible with the public's expectation for exceptional environmental quality and reduced energy security risks. Following this premise, one of FE's key program goals is to develop a zero emission coal power plant by 2015 (FE GG 4.55). In order to achieve this goal, public/private partnerships have been established to develop key technologies. Testing was initiated in 2004 on membrane technology that would separate hydrogen from gasified coal which could then be used as an environmentally friendly fuel for power generation (FE GG 4.55.2.2). This is one of the many steps toward achieving the 2015 goal.

To support the General Goal by promoting a diverse

supply of energy, FE also focuses on increasing the availability of natural gas and oil (FE GG 4.56). Technologies will be developed to increase domestic supplies from unconventional sources, such as methane hydrates (see the following insert). The development of technologies, such as this, is sponsored by the Federal government because it is long term and high risk and therefore would not be

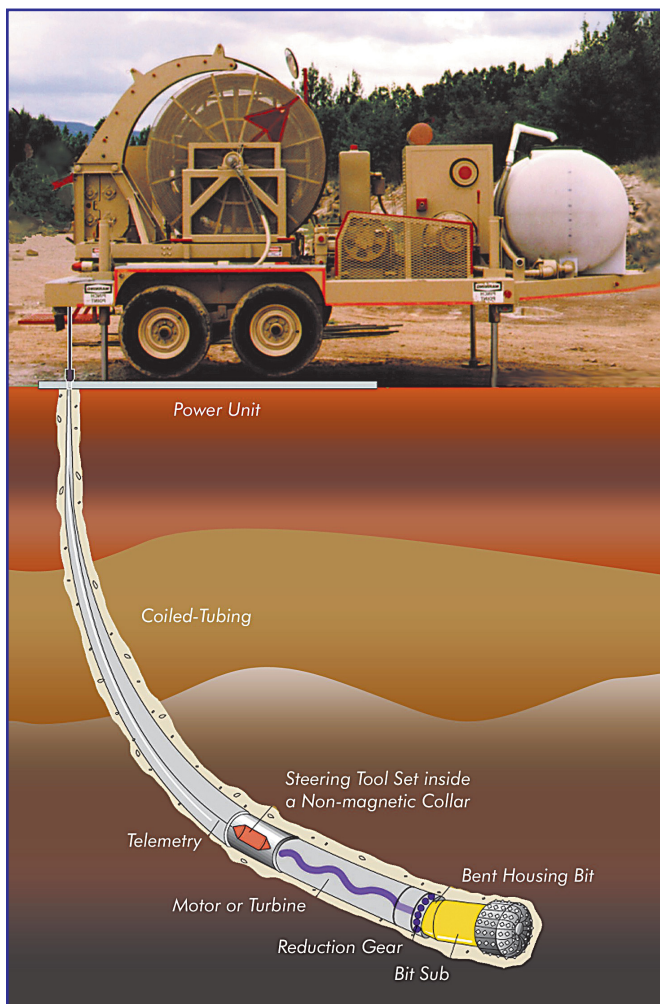


**Methane Hydrates.** *The United States Geological Survey study estimated the in-place gas resource within the methane hydrates of the United States to range from 112,000 trillion cubic feet to 676,000 trillion cubic feet, with a mean value of 320,000 trillion cubic feet of gas. This volume is larger by several orders of magnitude than previously thought and dwarfs the estimated 1,400 trillion cubic feet of conventional recovered gas resources and reserves in the United States.*

funded by the private sector. In FY 2004, laboratory studies and feasibility analyses were completed in the areas of drilling vibration monitoring and control, high-temperature electronics, and specifications were developed for high temperature silicon to be used on key insulator components. In addition, simulation software was completed which integrated 3-D seismic data offering enhanced capabilities to locate new natural gas deposits, and thus contributed to the goal of increasing energy availability (FE GG 4.56.1).

FE's key program goal for oil is to manage and fund oil exploration and production research and policy which results in development of domestic oil resources in an environmentally sound and safe manner (FE GG 4.57). Similar to the approach being used for natural gas recovery, in 2004, FE





**Microhole Systems** One way to potentially lower the relatively high costs of locating and producing hydrocarbons in the United States may be to reduce the size of the borehole and the equipment needed to drill it. This program is exploring new concepts for miniaturized drilling systems.

conducted innovative research (see the above Microhole Systems diagram) for enhanced oil recovery technologies, improved computer simulation software to better identify hydrocarbon targets, and initiated a fracture development timing study for Alaska's Brook Range to further characterize the location and availability of oil reserves in Alaska (FE GG 4.57.1). Through these and other initiatives, FE continues to pursue efforts that will increase the amount of oil that can be recovered from domestic sources.

By reducing the adverse economic impact of a major petroleum supply interruption to the U.S., the SPR has a direct affect on our energy security. For the SPR, energy security is measured by how quickly the program can respond to a Presidential

*"The Strategic Petroleum Reserve is an important element of our Nation's energy security. To maximize long-term protection against oil supply disruptions, I am directing...the Secretary of Energy to fill the SPR up to its 700 million barrel capacity."*

*President George W. Bush*

direction to draw down, how much of the oil inventory is available, and the cost efficiency of operations. Therefore, the key program goal is to maintain operational readiness to drawdown at a sustained rate of 4.4 million barrels per day for 90 days, within 15 days notice by the President and fill the SPR to 700 million barrels by 2005 (FE GG 4.58). In 2004, 46 million of barrels were added to the reserve resulting in a total inventory of 670 million barrels, thereby exceeding the target of 656 million barrels. This also provided 56 days of net import protection (FE GG 4.58.1).

More detailed information concerning the performance results for the above referenced goals and targets is available in the Performance Results section.

## Nuclear Energy

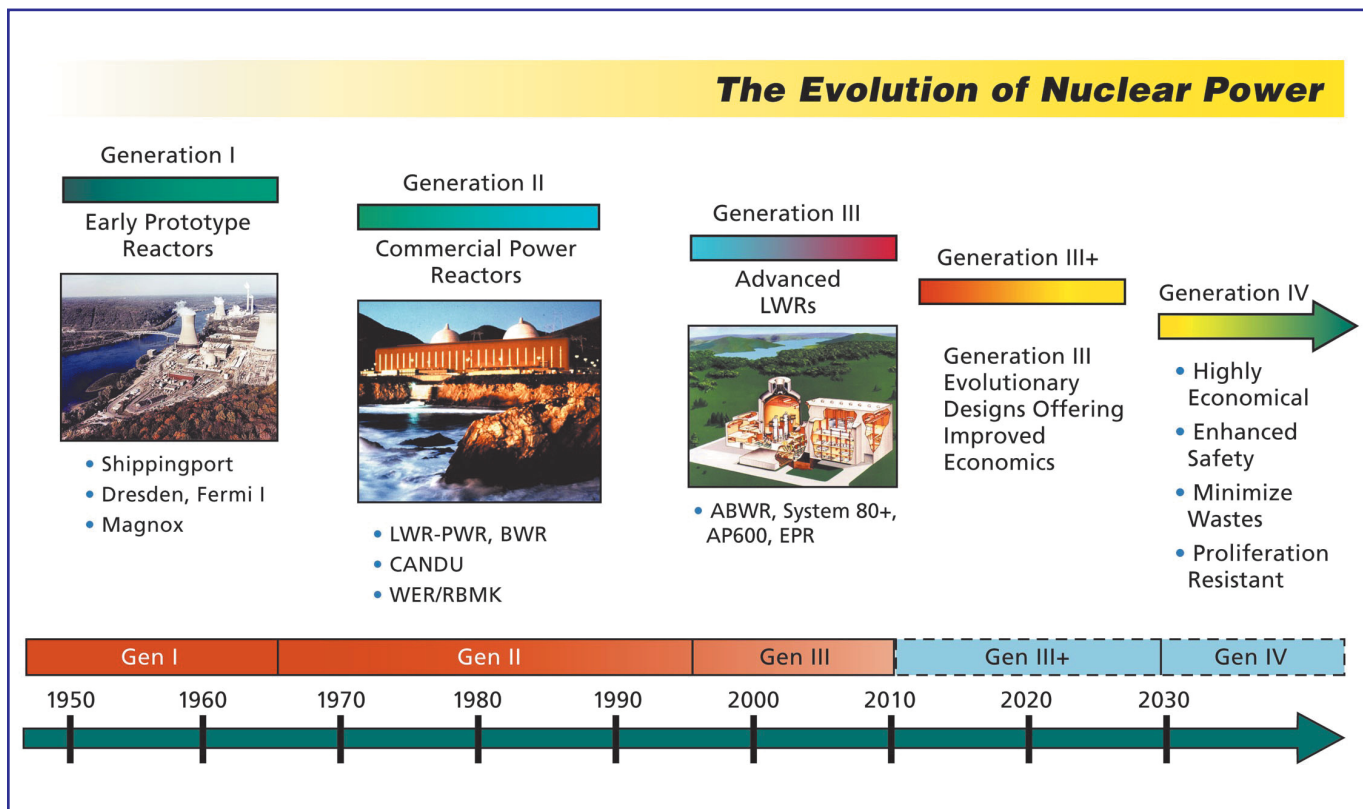
The Department's nuclear energy R&D programs directly support the Energy Security General Goal of improving energy security by developing the nuclear energy technologies necessary to make nuclear energy part of a diverse supply of reliable, affordable, and environmentally sound energy. These R&D programs address both near-term and long-term nuclear energy critical issues. These issues include the risks associated with the permit and licensing process for the construction and operation of the next new nuclear power plant and the engineering of new materials, fuels, and reactor designs for the next generation of U.S. nuclear power plants that must be able to efficiently and safely generate both electricity and hydrogen. These next generation plants must produce less waste, have much lower radiotoxicity, and be proliferation resistant.

The Nuclear Power 2010 program has the goal of lowering the technical, institutional, and regulatory barriers to enable the nuclear power industry to order new nuclear power plants that can be deployed early in the next decade (NE GG 4.14). In 2004, the Department met its goal by receiving three financial assistance applications for nuclear power plant licensing demonstration projects in response to the Nuclear Power 2010 program solicitation (NE GG 4.14.1). The cost-shared projects awarded will support plans to demonstrate for the first time the U.S. Nuclear Regulatory Commission's untested combined Construction and Operating License (COL) process.

The Generation IV Nuclear Energy Systems Initiative program is conducting the R&D to develop next-generation nuclear energy systems that excel in safety, sustainability, cost-effectiveness and proliferation resistance. In May 2004, the Department issued a Request for Information and Expressions of Interest announcing the Department's interest in entering into a cooperative agreement for the conduct of the research, development and demonstration of a next-generation nuclear reactor coupled to advanced electricity

and hydrogen generation technologies. Thirteen expressions of interest were received from U.S. companies interested in leading this effort along with comments from 40 companies and organizations with an interest in the future of nuclear power.

In conjunction with Generation IV, the Advanced Fuel Cycle Initiative is addressing long-term solutions for managing nuclear wastes by developing advanced, proliferation-resistant nuclear fuel technologies that reclaim the energy remaining in spent nuclear fuel, minimize wastes, and perform in a safe and environmentally sound manner (NE GG 4.15). In FY 2004, NE met a key target by demonstrating the separation of long-lived radioisotopes from spent nuclear fuel at laboratory scale (NE GG 4.15 3). The development of these separation technologies will permit economical reduction of the volume and heat load of high-level nuclear waste requiring repository disposal. Successful development of a full range of advanced spent fuel treatment and recycle technologies will significantly reduce the cost of geologic disposal while simultaneously reducing inventories of civilian plutonium.



*Timescale for the development and implementation for next generation nuclear power technology.*



NE's Nuclear Hydrogen Initiative is an integral part of the President's Hydrogen Fuel Initiative that has the goal of developing technologies for economically generating, storing, and distributing commercial quantities of hydrogen. NE's Nuclear Hydrogen Initiative is developing technologies for using the extreme-high temperatures found in some nuclear reactor designs to generate hydrogen on a commercial scale (NE GG 4.14). In FY 2004, a key target to complete the final designs of the baseline thermochemical and high-temperature electrolysis laboratory-scale experiments was met (NE GG 4.14.3). These laboratory-scale experimental results are needed for the design of pilot-scale experiments and ultimately the engineering-scale demonstration that will demonstrate the feasibility of nuclear hydrogen production on a commercial scale.

The Nuclear Energy Research Initiative (NERI) has realized its original goal of developing advanced nuclear energy systems and technology to help assure that the U.S. maintains a viable option to use nuclear energy to meet its energy and environmental needs. The research effort, conducted by the Nation's universities, laboratories, and industries, has helped to maintain and improve the nuclear research infrastructure in this country and has focused attention on the United States as a nuclear research and development leader. In FY 2004, the NERI program focused on advanced nuclear research at the Nation's universities and integrated the universities into the Department's mainline nuclear energy R&D programs described above. A solicitation, open to all U.S. universities, was issued in June 2004 and resulted in over 161 research proposals for evaluation by the Department.

To ensure that highly-talented nuclear engineers and scientists enter the work force to meet the current and future U.S. demand, NE maintains and enhances the Nation's nuclear infrastructure, which includes providing reactor fuel, reactor upgrades, and grant programs at the six regional university consortia and associated research reactors (NE GG 4.17). In FY 2004, NE met or exceeded the annual target by providing fuel to these reactors, funding 26 industry-matching grants, providing 20 equipment and instrumentation upgrades, providing 51 nuclear engineering education research grants and providing 21 fellowships and 54 scholarships (NE GG 4.17.1). This effort is reversing a previous steep

decline in the number of graduating nuclear engineers and scientists.

The Radiological Facilities Management program maintains and operates irreplaceable DOE nuclear technology facilities in a safe, secure, environmentally compliant and cost-effective manner to support national priorities (NE GG 4.17). Central to this infrastructure is the Nation's nuclear technology laboratory, the multi-program Idaho National Laboratory. The Radiological Facilities Management program also supports the oversight and planning required to assure that the Department's nuclear fuel assets – principally the Paducah Gaseous Diffusion Plant – can respond as required to future national requirements. As an example of efficiency, the Department met the annual target by maintaining and operating the radioisotope power systems facilities with less than 10 percent unscheduled downtime from their approved FY 2004 baseline (NE GG 4.17.4).

More detailed information concerning the performance results for the above referenced goals and targets is available in the Performance Results section.

## Energy Efficiency and Renewable Energy

EERE's programs address both the supply and demand sides of the energy security equation. EERE's program activities are conducted in partnership with the private sector, state and local governments, DOE national laboratories, and universities. Highlighted on the following pages are the hydrogen technologies, solar technologies, vehicle technologies, weatherization and wind energy programs.

Through partnerships with the private sector, the President's Hydrogen Fuel Initiative seeks to develop hydrogen, fuel cell, and infrastructure technologies needed to make it practical and cost-effective for large numbers of Americans to choose fuel cell vehicles by 2020. The initiative will dramatically improve America's energy security by significantly reducing the need for imported oil. Hydrogen technology contributes to energy security by developing lower-cost means of producing and delivering hydrogen in large quantities from natural gas, coal, renewable-based electricity, and nuclear power; and developing fuel cell and hydrogen delivery infrastructure technologies.



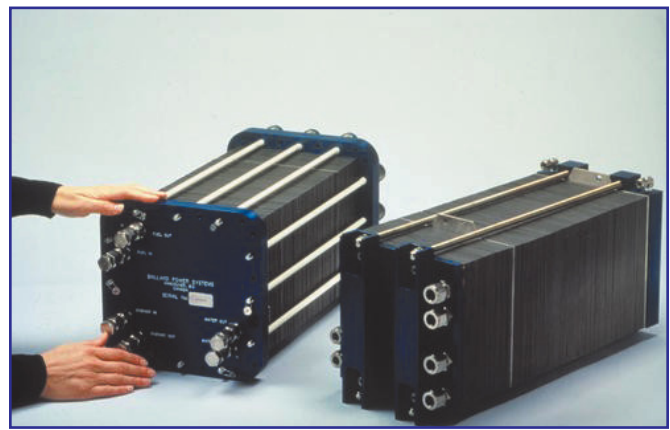
*"A simple chemical reaction between hydrogen and oxygen generates energy, which can be used to power a car producing only water, not exhaust fumes. With a new national commitment, our scientists and engineers will overcome obstacles to taking these cars from laboratory to showroom so that the first car driven by a child born today could be powered by hydrogen, and pollution-free. Join me in this important innovation to make our air significantly cleaner, and our country much less dependent on foreign sources of energy."*

*President George W. Bush  
State of the Union Address*

The program supports the FreedomCAR Partnership (Cooperative Automotive Research) and the President's Hydrogen Fuel Initiative which has as its long-term goal of an industry decision to commercialize hydrogen-powered fuel cell vehicles by the year 2015 and the vision of a diverse, secure, and emissions-free energy future.

The Hydrogen and Fuel Cell Technology program is conducting R&D to develop hydrogen production, storage, and delivery technologies to the point that they are cost and performance competitive and are being used by the Nation's transportation, energy, and power industries. The Program will expand and support the General Goal by making our clean domestic energy supplies more flexible to dramatically reduce or even end dependence on foreign oil (EE GG 4.01). In 2004, the cost-competitive target of \$200 per kilowatt for a hydrogen fueled 50 kilowatt fuel cell power system was achieved (EE GG 4.01.j).

The Solar Energy Technologies program helps America meet its energy needs by developing solar energy devices (see solar dish-engine system on the following page) and systems that are more efficient,



*A fuel cell uses the chemical energy of hydrogen to produce electricity and water, cleanly and efficiently.*

reliable and affordable. More specifically, the key Solar program goal expects to improve performance of solar energy systems and reduce development, production and installation costs to competitive levels. This helps address the need to improve the mix of energy options available as outlined by the General Goal. This will accelerate large-scale usages across the Nation and make a significant contribution to a clean, reliable and flexible U.S. energy supply (EE GG 4.03). Laboratory testing of commercial production crystalline silicon modules during 2004 verified the modules' conversion efficiencies in support of the program's goals (EE GG 4.03.01).

The Vehicle Technologies program contributes to energy security by developing technologies that enable the production of highly efficient cars and trucks. Activities in the Vehicle Technologies program contribute to two cooperative government/industry initiatives: the FreedomCAR Partnership and the 21st Century Truck Partnership. The FreedomCAR Partnership is a collaborative effort among three domestic automobile manufacturers, five energy companies, and DOE for cooperative, pre-competitive research on advanced automotive technologies having significant potential to reduce oil consumption. The 21st Century Truck Partnership includes 16 industrial partners and 4 federal government departments working cooperatively to improve the energy efficiency and safety of trucks.

The key Vehicle Technologies program goal is to develop technologies that enable cars and trucks to become highly efficient through improved hybrid power technologies, cleaner domestic fuels, and



*This solar dish-engine system is an electric generator that “burns” sunlight instead of gas or coal to produce electricity. The dish, a concentrator, is the primary solar component of the system, collecting the energy coming directly from the sun and concentrating it on a small area. A thermal receiver absorbs the concentrated beam of solar energy, converts it to heat, and transfers the heat to the engine/generator.*

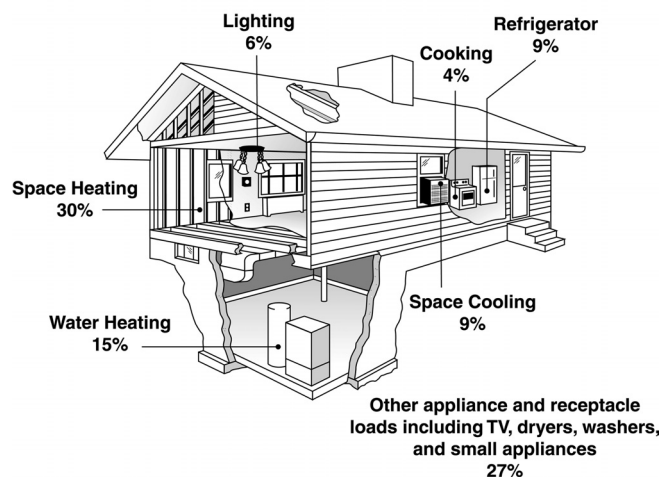
lightweight materials, to be cost and performance competitive (EE GG 4.02). Improving energy efficiency is a fundamental objective of the General Goal. Manufacturers and consumers will then use these technologies to help the Nation reduce both energy use and greenhouse gas emissions, thus improving energy security by dramatically reducing dependence on oil. In 2004, for example, the high power, light vehicle lithium ion battery cost was reduced to \$964 per battery system (EE GG 4.02.2) thereby exceeding the FY 2004 target cost of \$1,000 per battery system.

The Weatherization Assistance program improves the energy efficiency of the homes of low-income families through a network of 970 local agencies throughout the country (EE GG 4.09). It is one of the most important and longest running energy efficiency programs in this country. During the last 27 years, the Department’s Weatherization Assistance Program has provided services to more than 5.4 million low-income families. Weatherization of a

home saves the homeowner an average of \$224 per year in utility costs. In FY 2004, 99,614 homes were weatherized, thereby exceeding the annual target of 94,450 homes (EE GG 4.09.1).

The Wind Energy Technologies program leads the Nation’s R&D efforts to improve wind energy technologies that enhance domestic economic benefits from wind power development, and to address barriers to the use of wind energy in coordination with stakeholders. By 2012, the program goal is to complete technology R&D and collaborative efforts, and to provide technical support and outreach needed to overcome barriers – energy cost, energy market rules and infrastructure, and energy sector accept-

### Energy Use in a Typical Low-Income Household



*Since 1999, DOE has been encouraging the network of weatherization providers to adopt the whole-house approach whereby they attack residential energy efficiency as a system rather than as a collection of unrelated pieces of equipment.*

ance – to enable wind energy to compete with conventional fuels throughout the Nation in order to serve and meet energy needs (EE GG 4.05). This key program goal addresses the advancement of the General Goal in many ways – developing new technologies, providing a mix of energy options, and improving energy efficiency. In 2004, testing of prototypes was completed for the first advanced low wind-speed technology components, and detailed designs under the first public-private partnership project for full system low wind speed turbine development was completed, thereby achieving the annual target (EE GG 4.05.1).



More detailed information concerning the performance results for the above referenced goals and targets is available in the Performance Results section.

## Electricity Transmission and Distribution

OETD's sponsorship of R&D in the area of reliable electricity supply will effectively lead to the expansion of transmission capacity, thereby reducing bottlenecks and the risks of outages from transmission and power supply constraints. Technological improvements to intelligence and monitoring devices will allow operators to measure, track, and predict grid activity in real time and respond more quickly to minor disturbances before they spread. Real-time information management and advanced communication technologies will help prevent, detect, and resolve future power outages quickly and efficiently. Over the next 15 years, OETD's program goal is to lead a national effort to modernize the electricity delivery system (TD GG 4.12). The program goal contributes to DOE's national energy security goal by providing for reliable delivery of energy. As this wide area system is further developed over the next couple of years, it will provide the ability to assess critical real-time grid activity and, in turn, more adequately address disturbances before they result in brown-out or black-out situations. A prototype wide-area measurement system was installed and is operating in the Nation's Eastern Interconnection with 12 time-synchronized monitoring instruments that feed data into two data archiving and analysis locations, thereby meeting the annual target (TD GG 4.12.3).

More detailed information concerning the performance results for the above referenced goal and target is available in the Performance Results section.

## Power Marketing Administrations

In the Flood Control Act of 1944 and the DOE Organization Act, Congress directed the Department to transmit and market power generated at federal hydropower facilities and dispose of such power at the lowest possible rates to consumers consistent with sound business practices. The Power Marketing Administrations' program goals are to ensure that this hydropower is marketed and delivered while complying with industry reliability standards, meeting planned and required



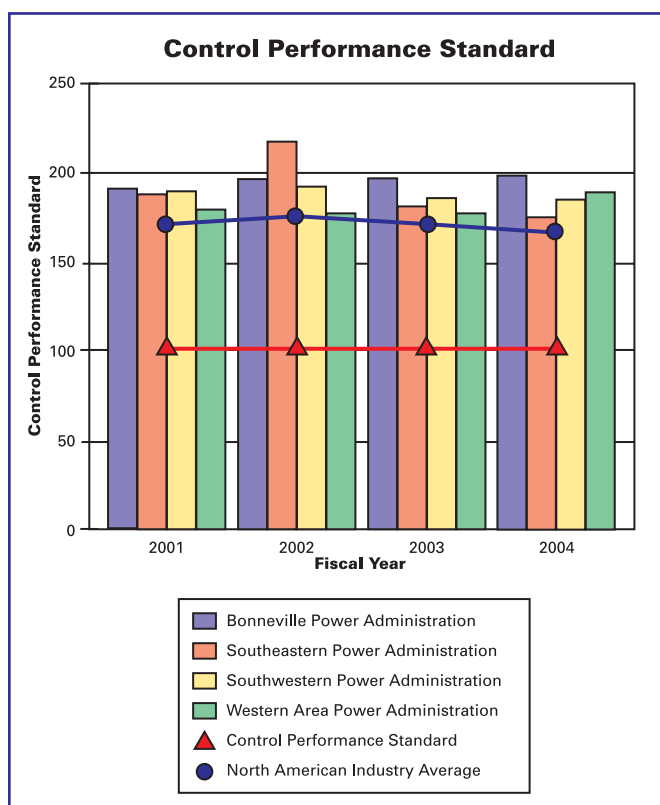
*Grid modernization is a substantial undertaking because America's electric systems are capital-intensive and far-reaching:*

- *10,000 power plants generate electricity*
- *157,000 miles of high voltage transmission lines deliver electricity*
- *3,100 utilities distribute electricity*
- *131 million commercial, industrial, and residential customers use electricity*

repayment, and achieving a recordable accident frequency rate at or below their safety performance standard (PMA GG 4.51-4.54). Each Power Marketing Administration uses these key program goals as a focal point as they implement individual power marketing programs based on regional hydropower sources and other factors inherent to their specific region of the country. By marketing and delivering Federal hydropower, the Power Marketing Administrations are directly contributing to the Department's Energy Strategic Goal by fostering a diverse supply of reliable, affordable, and environmentally sound energy while increasing the Country's mix of energy options.

In order to continue to achieve their program goals, the Power Marketing Administrations must provide power to their customer bases that is both reliable and affordable. Electrical system reliability came to the forefront on August 14, 2003, when much of the northeastern United States and parts of Ontario, Canada experienced a black-out with power not being restored in some affected areas for up to four days. System reliability continues to be a key focus of the Power Marketing Administrations as they operate and maintain their transmission systems in accordance with key Control Performance Standards developed by the North American Electric Reliability Council (NERC). For many years the Power Marketing Administrations have measured their system reliability in accordance with NERC Control Performance Standards 1 and 2 (PMA GG 4.51.1-4.54.1). As can be seen from the Control Performance Standard chart the Power Marketing Administrations have achieved NERC standards and operated their power systems reliably and efficiently.

More detailed information concerning the performance results for the above referenced goals and targets is available in the Performance Results section.



## Challenges and Future Expectations

President Bush's Coal Research Initiative promises tremendous energy benefits to the American people. In FY 2004, the Department continued to develop the technologies and processes to reap the maximum benefits from coal – the lowest cost, most abundant domestic energy resource. Over the next several years, the Department will extend its research of carbon sequestration – the capture and permanent storage of carbon dioxide produced by coal. Carbon sequestration is important because it acknowledges a simple fact: fossil energy – oil, gas, and coal – will continue for decades to be the lowest-cost energy resource worldwide. To meet this challenge the Department is focusing on FutureGen, a public-private partnership to design, build, and operate a virtually emissions-free, coal-fired, electricity and hydrogen production plant. This initiative will continue the Department's path forward to continue the development of technologies that foster a diverse supply of environmentally sound energy resources.

NE is a leader in the development of long-term, high-risk nuclear energy technologies while maintaining and enhancing the current nuclear infrastructure. NE is ensuring that nuclear technology plays a positive role in the foreseeable future by providing a vision and coordinating planning among governments, industries, laboratories, and universities of all nations interested in the future of nuclear energy. Specific examples of some of the challenges and expectations for the future for NE are:

- **National Nuclear Infrastructure:** NE is responsible for one of the world's most comprehensive nuclear research infrastructures constructed, for the most part, in the 1950s and 1960s. The existing infrastructure requires enhancements to provide the systems, fuels, and material testing requirements needed for advanced nuclear research and to support national priorities. NE will continue to make capital investments to replace or enhance processing equipment and infrastructure to ensure all NE facilities meet essential safety and environmental requirements and are maintained at user ready levels. For example, the Idaho National Laboratory (INL) has been designated to become the leading center of nuclear research and development for NE's strategic nuclear energy research and development enterprise.

- **National Nuclear Education Infrastructure:** NE continues to support programs that maintain and enhance national nuclear capabilities by producing highly trained nuclear scientists and engineers to meet the Nation's energy, environmental, health care, and national security needs. To do so, NE will continue to use educational incentives, including the fund matching grant program, to increase enrollments and graduates in nuclear engineering. This will help reverse the trend of the past twenty years that resulted in the erosion of the nuclear engineering infrastructure.

Renewable energy technologies hold tremendous promise in moving the Nation toward sustained, low-emission electricity and hydrogen supply. Government-sponsored R&D efforts over recent decades have been very successful in helping to lower costs and improve the reliability of renewable energy technologies, and more can be achieved with robust research and development in the future. An important factor is that renewable sources of generation will be designed to integrate into our existing distribution system. The tools that form the necessary interface between distributed energy systems and the grid are being developed to be less expensive, faster, more reliable and more compact. But as pointed out in the NEP, renewables don't always fit into traditional regulatory categories and are often subject to competing regulatory requirements, barriers which programs are working to address. For example, uniform interconnection protocols and regulatory treatments require developers of local renewable energy projects to negotiate interconnection agreements on a site-by-site basis. Specific examples of some of the challenges and expectations for the future for EERE are:

- **Hydrogen Technologies.** Achieving a hydrogen economy will require a combination of technological breakthroughs, market acceptance, and large investments in a national hydrogen energy infrastructure. Success will not happen overnight, or even over a few years, but over decades. It will require an evolutionary process that phases in hydrogen as the technologies and markets are ready. Success will also require that the technologies to utilize hydrogen fuel and the availability of hydrogen occur almost simultaneously.
- **Biomass Technologies.** Biomass, including agricultural crops, trees, wood wastes, plants, grasses, fibers, animal and other wastes, represents an

abundant, domestic and renewable source of energy that has tremendous potential to increase domestic energy supplies. The current focus of our biomass program is enabling the co-production of liquid fuels, chemical and material products, and power in "biorefineries." A thriving bio-industry's demand for biomass feedstock would increase employment and income for rural America while also contributing to the Nation's energy security.

- **Wind Technologies.** Wind energy is one of the most widely used and fastest growing renewable energies in the world. The Department is now focused on developing technology that can cost-competitively harvest more widely available, lower speed wind resources that are generally closer to populations and load centers. If successful, this "low wind speed" technology could expand the land area where wind can be developed by a factor of 20, while reducing the average distance between the wind resources and where power is needed by a factor of five.